Kira Marts

Oxford Scholars

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Genetic Consequences of Warfare

If trauma is not transformed, it can be transferred onto future generations ("Pain That's Not Transformed, Gets Transmitted"). Studies on this phenomenon reveal how traumatic events can alter the transcription of DNA for survivors (Fagan). Plagued by constant bombings, explosions, and warfare, Ukranians have experienced a relentless fear for nine months, with over 6 million citizens displaced in other countries ("Operational Data Portal"). Research on the DNA of Holocaust survivors and prisoners of war epitomize the effects of experiencing high stress levels for prolonged periods of time, leading to a a change in their genetic transcription. These epigenetic changes stem from the body's response to trauma in which large amounts of epinephrine (adrenaline), cortisol, and glucocorticoids (steroid hormone) are released but do not return back to normal levels. Geneticists examined this effect on the body among the descendants of Holocaust survivors and prisoners of war, discovering how the genetic transformations are passed down generationally. Oftentimes, these epigenetic changes result in higher chances of depression, anxiety, cancer, and heart disease. As stress-linked events continue to affect the mind and bodies of the Ukrainian people (as well as Russians), scientists can predict that survivors of this war will experience epigenetic changes as a result of their endured trauma.

Epigenetic Changes

Epigenetic changes are caused by an increase in methylation of DNA. The composition of DNA can be described as a double helix, allowing for a unique folding structure. DNA

"fold[s] around histone proteins to create nucleosome complexes, nucleosomes physically regulate the access of proteins, such as transcription factors and enzymes, to the underlying DNA," (Zedalis). These histone proteins either tightly bind DNA together, preventing transcription, or loosen DNA, allowing for the genetic code to be transcribed. Once DNA is transcribed, genetic changes are then passed on; if transcription is prevented, DNA is altered through the decrease or increase of gene expression. While random mutations can arise, scientists have discovered that external factors can impact gene regulation; recent studies show how exposure to traumatic events can also change one's DNA. In times of stress, the body releases adrenaline, glucocorticoids, and cortisol, creating the "fight or flight" response. Normally, these hormone levels would return to normal, although for those who experience chronic stress, their levels would remain higher than usual. Consequently, high levels of cortisol, adrenaline, and glucocorticoids result in an increase in methylation; increased methylation can alter DNA transcription.

Evolution's Role in Epigenetics

Scientists believe that these genetic changes may be the body's way of preparing "you to fight harder or flee faster the next time you encounter something stressful," (Rzeszutek). Therefore, evidence reveals that epigenetic changes act as an evolutionary mechanism to prepare the body for stress in the future. The altered expression of DNA can prepare survivors' descendants for high concentrations of stress, while also increasing the likelihood of illnesses and syndromes.

Epigenetics and Generational Trauma

These epigenetic changes, caused by exposure to traumatic events, can be passed down through generations. The alteration of genes is believed to set diseases in motion for the descendants of the survivors of such trauma, as they are more likely to experience depression, anxiety, or cancer (Khazan). “Research has shown that the effects of trauma can be intergenerationally passed on through epigenetic mechanisms, such as methylation,” (Jiang et al.). This being said, “one of the main *vehicles* of intergenerational trauma transmission is the family,” producing consequences for future generations (Rzeszutek). By examining the DNA of descendants of Holocaust survivors, scientists have found abnormally high amounts of depression as well as increased stress levels (Khazan). Research reveals how traumatic events can alter DNA, thus producing generational effects. With the events of the Ukrainian-Russian war in mind, scientists can predict to see similar patterns in the descendants of Ukrainians and Russians, due to enduring continual stress and trauma.

Science of Prior War Trauma Survivors

Research on trauma altering the transcription of DNA began as scientists recognized the increasing number of syndromes and diseases in the descendants of Holocaust survivors. For those who endured the brutalities of the Holocaust, their experiences of persistent stress and trauma altered the transcription of their genetic code. This in turn led to greater cases of depression, anxiety, cancer, and heart disease. This idea “...of *intergenerational trauma* manifesting in psychopathological symptoms among descendants of Holocaust survivors—descendants who did not experience this kind of massive traumatization directly, [exemplified how descendants] were *secondarily traumatized* by parental traumatic history,” (H. Costa). Through these epigenetic changes, the grandchildren of Holocaust survivors were more

likely to experience constant guilt or shame, difficulties in social settings, as well as the physical consequences such as cancer or chronic pain (Rzeszutek).

Epigenetic changes as a result of extreme stress have also been examined in the descendants of prisoners of war. Scientists found that the sons of POWs were 1.11 times less likely to survive within their first 12 months compared to their female counterparts (H. Costa). The DNA of survivors experience epigenetic changes, later passing these genetic modifications onto their offspring.

Implications for the Russia-Ukraine Survivors

Children, adolescents, and adults are experiencing constant stress in Ukraine and Russia. From displacement to required enlistment for men ages 18-27, the citizens of Ukraine have endured unfaltering distress for nine months. One Ukrainian parent described the effects of the trauma their child endured while away from their guardian, stating her daughter experienced newly developed memory loss/forgetfulness (Gharib). As understood by scientists, "without a parent or guardian to offer love and support, children can experience the kind of stress that often leads to serious mental health and development consequences," (Gharib). Displacement and instability endured by the people of Ukraine can create effects for both the children and their future offspring. Moreover, Kate Pokrovskaya, a Ukrainian psychotherapist, explains how the deafening nature of consistent sirens exhausted her mentally and physically (Taub). Constant stress inducers contribute to unusually high hormone levels, acting as a trigger for epigenetic changes.

Additionally, for the young men required to enlist in the military, their stress can also act as a factor that may alter their DNA. While some citizens are experiencing high cortisol and

adrenaline levels due to fears of bombings and attacks in suburban areas, others are experiencing abnormal hormone levels due to worries about military service. Any extreme levels of stress caused by this wartime situation can give rise to epigenetic changes, and thus intergenerational trauma. Displacement and lack of parental support may act as an additional factor in stress for children and young adults — stress that can play a role in altering one's genetic code.

Families on the opposing side of the war may also experience epigenetic alterations and intergenerational trauma. For those enlisted in the war, whether voluntary or compulsory, witnessing trauma or sustaining abnormally high stress levels, may result in a prevention of DNA transcription. Therefore, the future offspring of these Russian survivors may experience the consequences of generational trauma.

As stated before, epinephrine (adrenaline) and cortisol are released in high stress situations. For those in Ukraine and Russia, their bodies are experiencing high levels of stress constantly, which will most likely result in harmful consequences. High stress levels increase methylation, either binding DNA tighter together or loosening DNA. This genetic modification is often seen as an evolutionary advantage to prepare future generations for similar stress levels. It can therefore be predicted that descendants of Ukrainians and Russians enduring war will experience greater chances of depression, anxiety, and heart disease (Khazan).

Concluding Remarks

The psychological impacts of intergenerational trauma, as seen in the descendants of Holocaust survivors and prisoners of war, may soon affect Ukrainians and Russians enduring the Russia-Ukraine war. This culturally-driven conflict has persisted since February, forcing many to bear witness to traumatic, war-entangled events. Displacement has caused citizens to feel a

severance from their children and culture. All of these factors can lead to increased hormonal levels, which in turn suppress immune systems, and increase the risk for illnesses and autoimmune diseases (Khazan). An increase in hormone levels such as adrenaline and glucocorticoids increases the risk for epigenetic mutations, which can leave descendants with a greater chance of depression, anxiety, and heart disease (Khazan). Thus, as the combat carries on, it's evident that survivors may not be able to return to their pre-war lives due to changes in gene expression. While the effects of this conflict are visible in the death toll and in the immense environmental destruction, more consequences may reveal themselves in future generations, as epigenetic changes may be rooted into the genetic code of the survivors' descendants.

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